# Strategic Environmental Research and Development Program: Climate Change-Related Research

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**Program Manager for Sustainable Infrastructure**
**SERDP/ESTCP**

Brief to the Coastal Engineering Research Board
June 22, 2010


SERDP

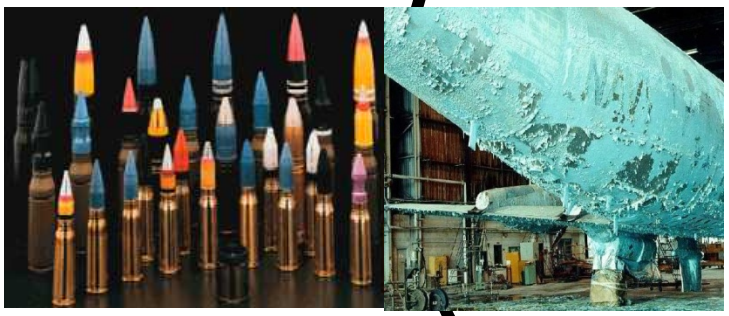
# DoD's Environmental Science and Technology Programs

- Science and Technology Research
- Demonstration/ Validation

# Current Program Area Management Structure

**Munitions Management**

**Weapons Systems & Platforms**



**Environmental Restoration**

**Sustainable Infrastructure**

# Program Transition

## Current: Sustainable Infrastructure (SI)

- Natural Resources
- Cultural Resources
- Facilities
- Energy

## Future (July 2010): 2 new Program Areas

- Resource Conservation and Climate Change
  - Natural Resources
  - Cultural Resources
  - Climate Change
  - Air Quality

- Energy and Water

# Climate Change R&D

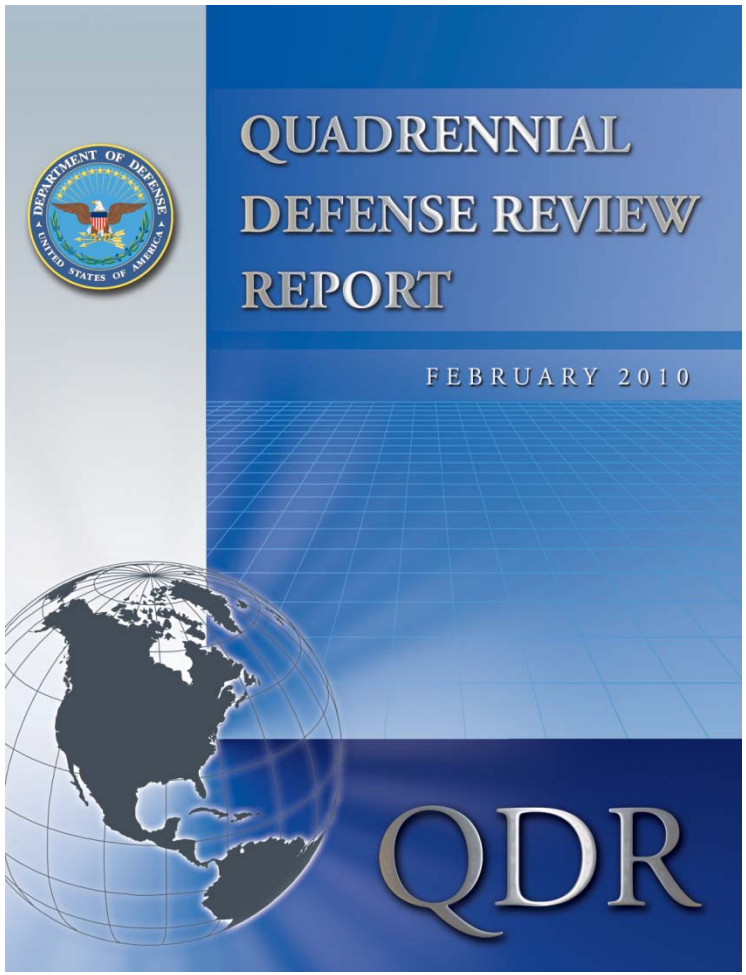
## Why is Climate Change of Concern to the Department of Defense?

- Climate change will directly impact national security:
  - DoD's built and natural infrastructure, which serves as the basis for sustaining military readiness;
  - Cost and availability of energy required by DoD to operate;
  - Stability of regions of the world unable to adequately respond to the impacts of climate change; and
  - Frequency and intensity of humanitarian crises due to natural disasters.
- SERDP & ESTCP role is to address through R&D the first two areas of concern.

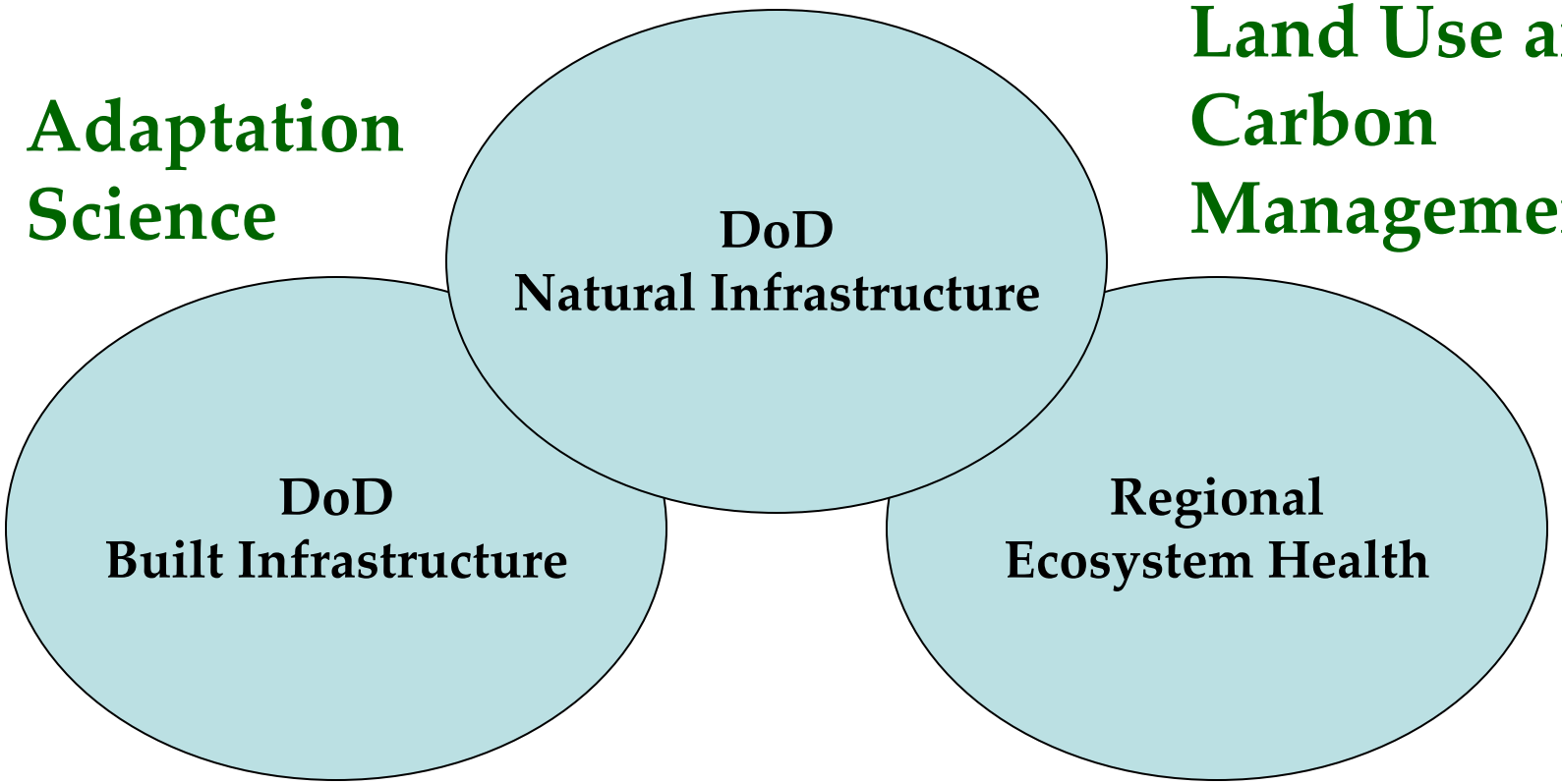
# SERDP/ESTCP & the Quarterly Defense Report

## *Crafting a Strategic Approach to Climate and Energy*

- "The Department will leverage the Strategic Environmental Research and Development Program, a joint effort among DoD, the Department of Energy, and the Environmental Protection Agency, to develop climate change assessment tools."
- "The Department will also speed innovative energy and conservation technologies from laboratories to military end users. The Environmental Security and Technology Certification Program uses military installations as a test bed to demonstrate and create a market for innovative energy efficiency and renewable energy technologies coming out of the private sector and DoD and Department of Energy laboratories."



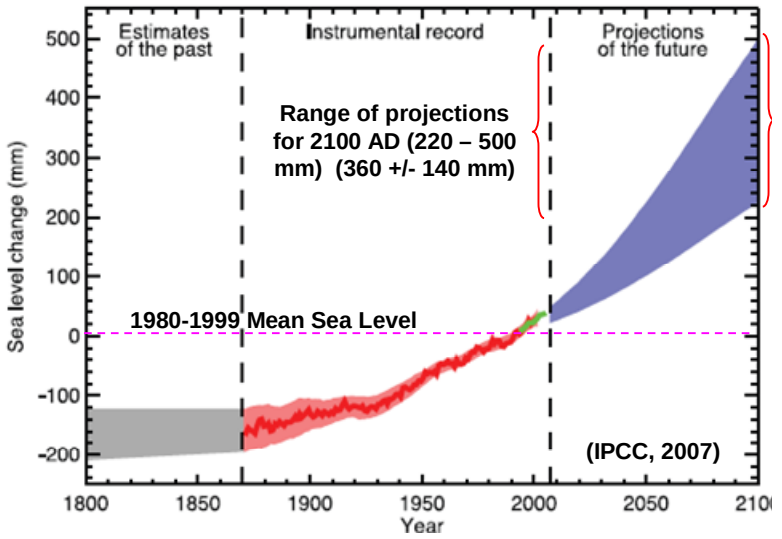
# SERDP/ESTCP Climate Change RDT&E Typology



# Climate Change Impacts and Adaptation

## Currently Funded Projects

- Sea level rise impacts (four projects)
- Assisted migration/ colonization of transition zone plant species (one project)
- Salt march response mechanisms (one project)
- Impacts to shorebird habitat and population viability (one project)




- Climate change interactions with fire, invasive species, and ephemeral and intermittent stream ecology in the Southwest (seven projects)

# FY11 SERDP Climate Change-Related New Start Projects

- Impacts of Climate Change on Alaskan Ecological Systems
- Ecological Forestry and Carbon Management

# Sea Level Rise & Storm Surge Impact Projects:
## R&D Effort to Address a Significant Threat to Coastal Military Installations

- Dynamical Phenomena
  - Prescribed scenarios
    - 0.5m, 1.0m, 1.5m, 2.0m local mean sea level rise by 2100
  - Interaction with storm surge as affected by storm intensity and frequency
- Physical effects considered:
  - Inundation
  - Storm damage
  - Shoreline erosion
  - Loss of wetlands
  - Barrier island impacts
  - Salt water intrusion
- Assessment of military installations in different regions:
- Impact assessment of:
  - Infrastructure
  - Mission capability

# Sea Level Rise and Storm Surge Impact R&D—continued

Multi -investigator teams focused on different geographical and physical settings:

- Eglin AFB along the Gulf of Mexico/barrier islands.
  - Florida State & URS Corp. (SI-1700)
- Military installations within the Hampton Roads area of the Atlantic Coast with a focus on Norfolk NB/tidal basin without barrier islands.
  - US Army Engineering R&D (SI-1701)
- Eglin AFB along the Gulf of Mexico and Marine Corps Base Camp Lejeune along the Atlantic Coast/focus on barrier islands.
  - Woods Hole Oceanographic Inst. & Univ. Hawaii
- Marine Corps Base Camp Pendleton and Naval Base Coronado along the southwestern Pacific Coast/coastal terraces (cliffs) behind beaches.
  - SPAWAR, San Diego State, UC San Diego & TerraCosta (SI-1703)

# Sea Level Rise and Storm Surge Impact R&D—continued

- All projects will use a 2000 baseline for initiating scenarios
- Based on the above and using 2100 to anchor the end point of each scenario, projects will apply a common rate of rise formula based on USACE (2009: CECW-CE Circular 1165-2-21)
- All projects will apply NAD83 and NAVD88 as the respective horizontal and vertical datums
- Projects will rely on refinements to historical storm patterns rather than attempt to project future patterns under climate change

# Sea Level Rise and Storm Surge Impact R&D—continued

- $5.5M over 3 years (FY09–FY11)
- Outcomes
  - New analytical methods and refined models for impact assessment that in combination can address the broad range of vulnerable DoD military infrastructure
  - Improved understanding of the potential range of impacts to specific geographic areas and installations that are the subject of study
- First In-Progress Review:  February 2010
- Symposium Technical Session:  December 2010
- Second In-Progress Review:  Spring 2011

# QUESTIONS?

# Strategic Environmental Research and Development Program (SERDP)

- Established by FY 1991 Defense Authorization Act
  - DoD, DOE, and EPA partnership
- SERDP is a requirements driven program that:
  - Responds directly to user requirements generated by the Services
  - Identifies high-priority, DoD environmental science and technology needs or investment opportunities that address these requirements

# Environmental Security Technology Certification Program (ESTCP)

- Established in 1995
- Demonstrate innovative and cost-effective environmental methodologies and technologies
  - Capitalize on past investments
  - Transition methods and technology out of the lab and field
  - Validate operational cost and performance
- Promote implementation
  - Identify DoD user community
  - Satisfy users by direct application at a DoD facility/site
  - Gain regulatory acceptance
  - May lead to technology transfer outside of DoD

# EFFECT OF NEAR-TERM SEA-LEVEL RISE ON COASTAL INFRASTRUCTURE (SI-1700)

- **PI:** Joseph Donoghue, Ph.D., P.G., Florida State University: coastal processes, sea-level change, climate change, geochronology.
- **Co-PI's:**
  - James Elsner, Ph.D., Florida State University: hurricane climatology and statistics, storm risk, statistical modeling
  - Bill Hu, Ph.D., Florida State University: groundwater-seawater interactions, solute transport, numerical modeling
  - Stephen Kish, Ph.D., Florida State University: remote sensing and GIS applications, surface water hydrology, spatial data
  - Alan Niedoroda, Ph.D., P.G., URS Corporation: coastal morphodynamics, sediment transport, numerical modeling
  - Christopher Reed, Ph.D., URS Corporation: coastal processes, numerical modeling, basin-level water quality analyses
  - Yang Wang, Ph.D., Florida State University: effects of sea-level change on coastal wetlands and the carbon cycle, paleoecology, paleoclimatology, stable isotope analysis
  - Ming Ye, Ph.D., Florida State University: groundwater modeling, site characterization, contaminant transport, uncertainty and risk analysis

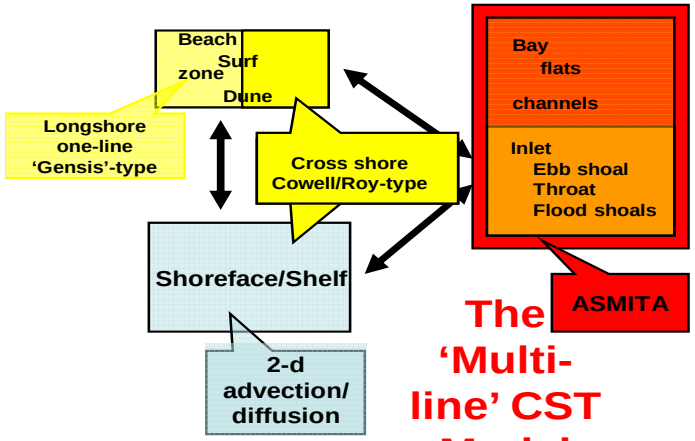
## Technical Objectives

- Identify and quantify the responses of coastal system components to sea-level rise and increased hurricane activity out to 2100 AD.
- Develop guidelines for using existing techniques and developing new methods for evaluating risk to coastal military installations.
- Develop probability methods for quantifying uncertainty in coastal risk analysis.
- Enable the evaluation of mitigation and adaptation strategies for near-future climate change.

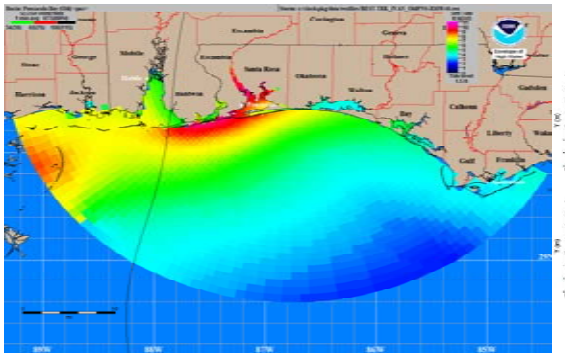
## Progress To Date

- Compiled and synthesized all available data on coastal morphologic change in response to sea-level rise and climate change in Eglin AFB region over historic time (150 yr) and pre-historic time.
- Quantified occurrence of major storms in Eglin region over geologic time into storm database; using database to model future storm characteristics.
- Adapted HURISK storm model for use in Eglin AFB region; initiated integration with HAZUS model of coastal infrastructure impacts.
- Adapted coastal process-response models for use in Eglin AFB region.

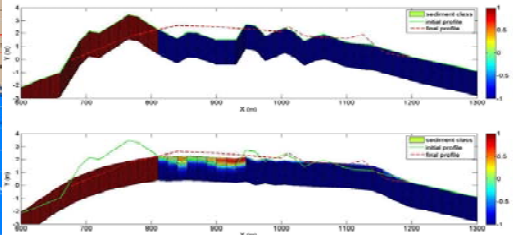
# Modeling the Response of the Coastal Environment to Climate Change by Integrating Several Process-Driven Models



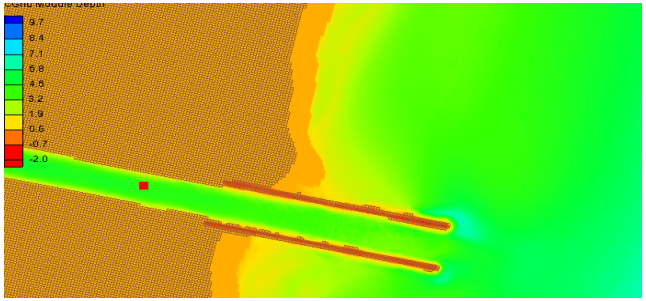

The 'Multi-line' CST Model



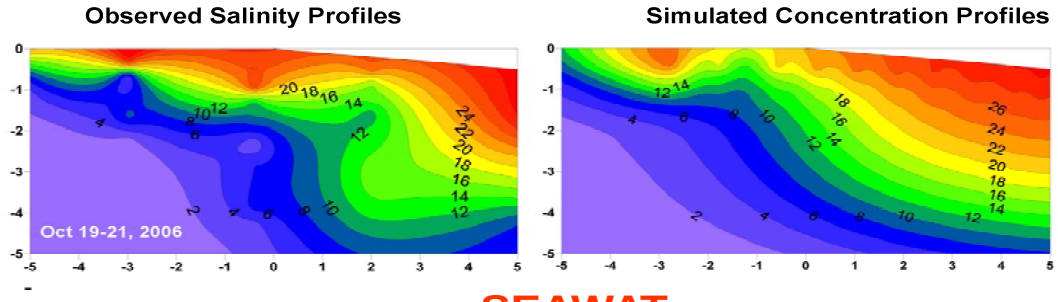
SLOSH with SWAN



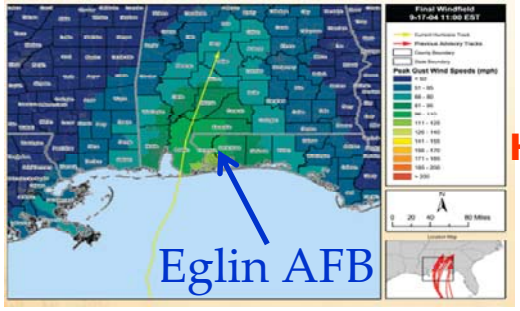
X-Beach



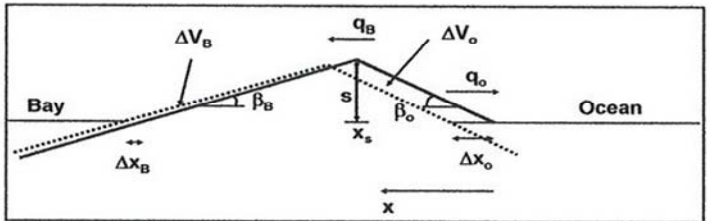
CMS-FLOW 2D (former M2D)



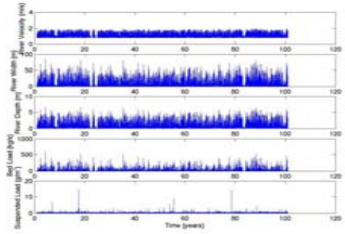

SEAWAT




HAZUS

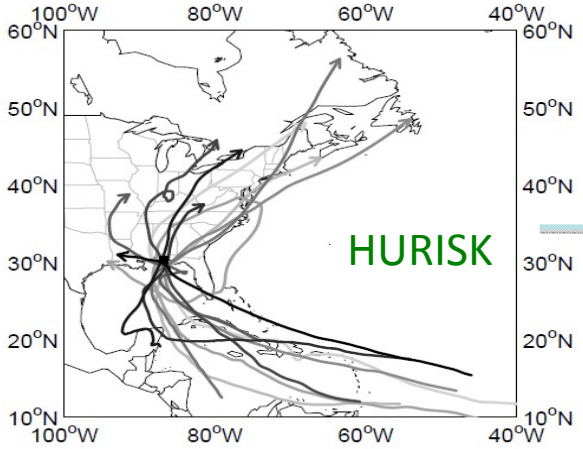



Cascade – Coastal Dune

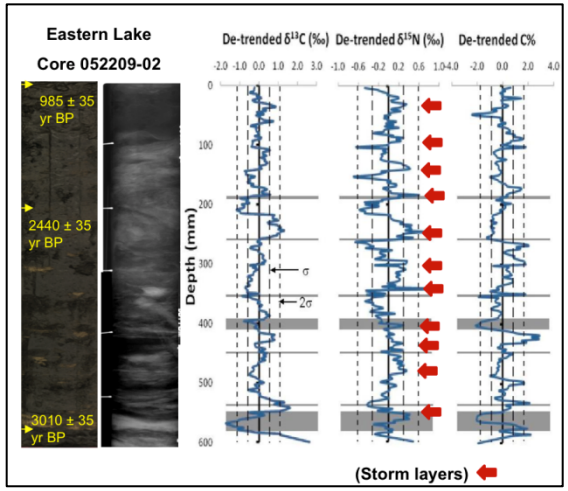


Hydrotrend

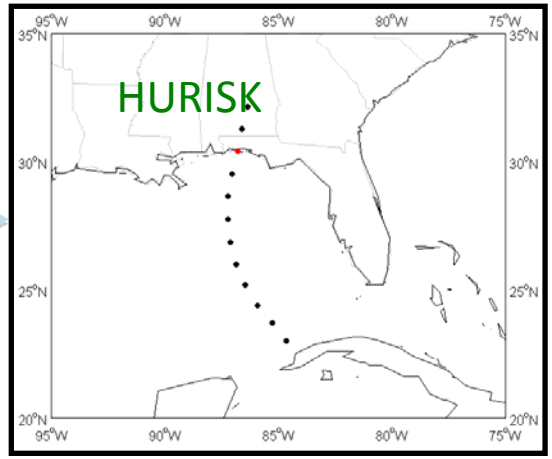
# Modeling Future Storms: Integration of HURISK and HAZUS



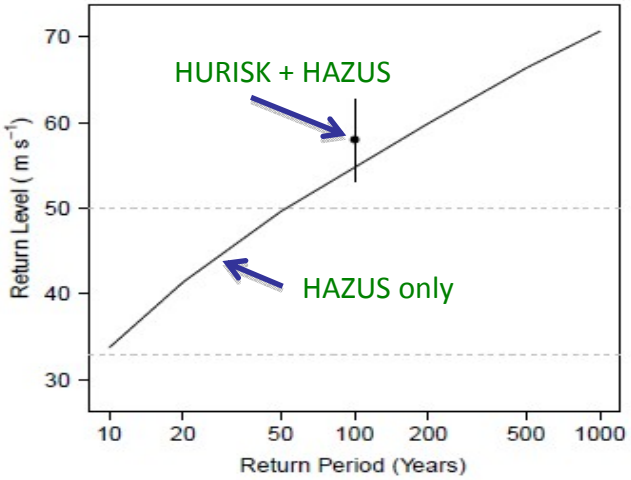

Tracks of all the strong hurricanes that have affected Eglin AFB since 1851, from HURISK database.



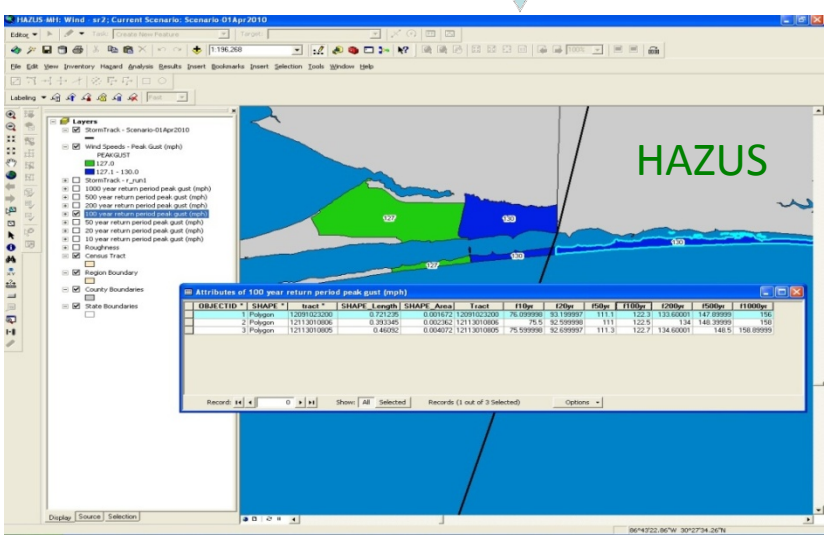

Paleo-storm frequency data from coastal sediment cores.




Locations along an average track of the strongest hurricanes. The locations are used to determine maximum wind speed and other hurricane characteristics using HURISK.




Return level (wind speed) versus return period. The point indicated is the 100-year hurricane wind speed at the Santa Rosa Island census tract, using the HURISK/HAZUS model integration. The vertical bar is the 90% confidence interval on the wind speed. The solid curve is the return-level plot using the HAZUS-only synthetic hurricane model.




Maximum wind speed in census blocks using the HAZUS wind field model and the HURISK hurricane model.

# Risk Quantification for Sustaining Coastal Military Installation Assets and Mission Capabilities (SI-1701)

## Project Team : USACE ERDC EL-CHL-GSL-CERL:

- Hydrodynamic Modeling
  - Dr. Jane Smith
  - Dr. Jay Ratcliff
  - Dr. Honghai Li
  - Dr. Cary Talbot
- Geomorphologic Modeling
  - Dr. Andrew Morang
  - Ms. Tanya Beck
- Environmental Modeling
  - Dr. Craig Fischenich
  - Mr. Kyle McKay
- Installation Modeling
  - Dr. Michael Case
  - Mr. Steve Pranger
- Asset Damage Modeling
  - Dr. Paul Mlakar
  - Mr. Steve Lofton
- Database Development and Spatial Analyses
  - Mr. Scott Bourne
- Risk Assessment Modeling
  - Dr. Martin Schultz
  - Dr. Edmond Russo (PI)
  - Ms. Kelly Burks-Copes

# Technical Objectives

- Advance knowledge of coastal hazard risk assessment as a basis for risk management at installations

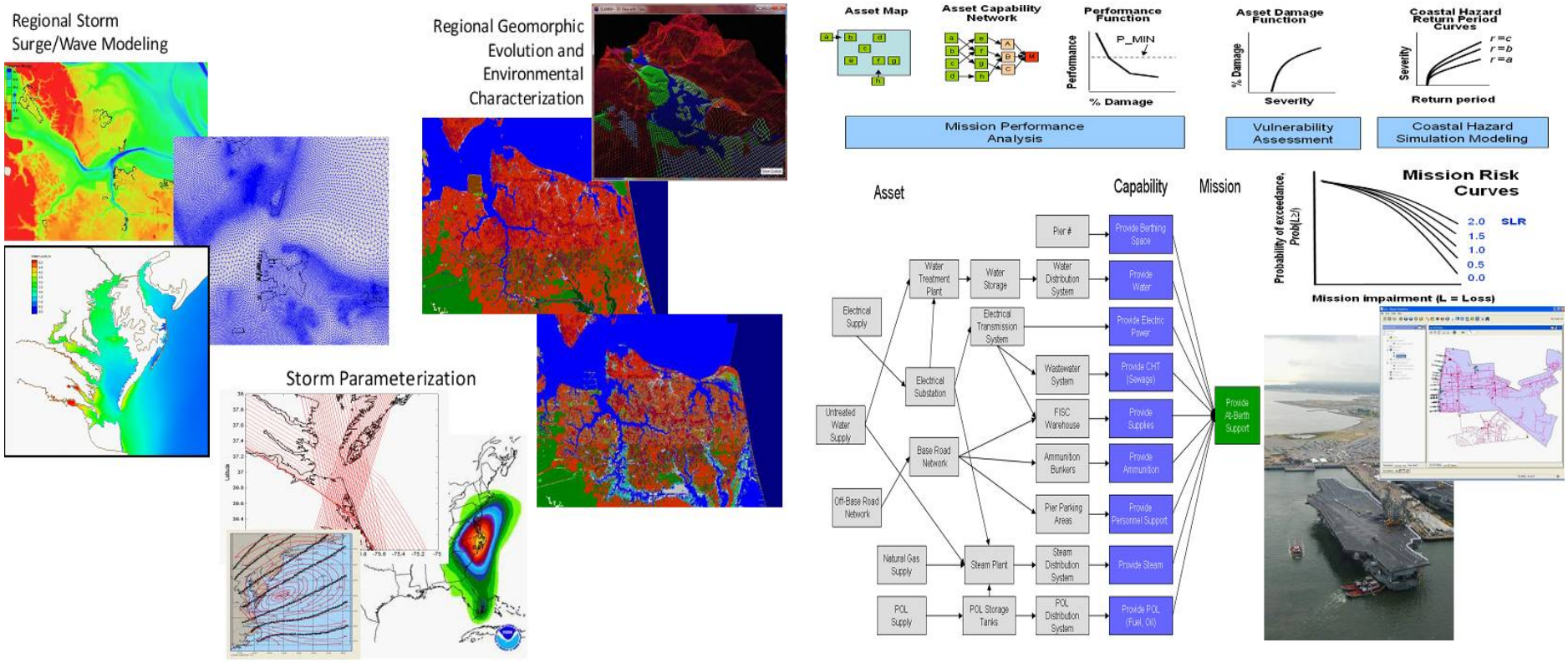
- Conduct quantitative modeling and risk assessment to:
  - Understand scope and magnitude of climate change effects in existing and future no-action coastal installation conditions
  - Identify thresholds at the onset of significant installation losses due to climate change effects

- Transfer demonstrated methods, tools, and technologies on risk assessment into military community of practice

# Progress to Date

- Methodology development:
  - Performed tiered operational risk assessment
    - Site selection in Hampton Roads region based on risk indicators
    - Developing installation-specific risk assessment methodology
  - Designed and assembling database to inform risk assessment scenarios
- Information development for climate change scenarios:
  - Regional tasks underway
    - Geomorphic and landscape evolution
    - Coastal hazard-frequency modeling (wind, water, sedimentation)
  - Installation-specific tasks underway
    - Mission association to Asset Capability Network (ACN)
    - ACN operationalization
    - Nearshore hydrodynamics (surge/waves, runup, and overtopping)
    - Installation flood water routing (surge/waves, precipitation, surface runoff)

**Responsive to the FEB 2010 QDR, the SERDP SI-1701 Project is a significant step on the path forward in the US military's adaptive management strategy to incorporate potential climate change effects in daily operations and long-term risk-based planning.**



# Shoreline Evolution and Coastal Resiliency at Two Military Installations: Investigating the Potential for and Impacts of Loss of Protecting Barriers (SI-1702 )

**Dr. Rob. L. Evans**
Woods Hole Oceanographic Institution
Specialist in Marine Geophysics

**Dr. Andrew Ashton**
Woods Hole Oceanographic Institution
Specialist in Coastal Modeling and Morphodynamics

**Dr. Jeffrey Donnelly**
Woods Hole Oceanographic Institution
Specialist in Storm and Sea Level Impacts

**Dr. Kwok-Fai Cheung**
University of Hawaii
Providing High resolution Inundation Models

# Technical Objectives

Specific objectives to be addressed by our study are:

•Identify how protecting barriers are likely to respond to 0.5, 1.0, 1.5, and 2.0 m of sea-level rise over the coming century

•For associated sea-level rise rates, assess the potential that barriers will no longer be able to keep up with sea level and will drown completely

•Understand how storms will work in concert with sea-level rise to exacerbate barrier loss.

# Progress to Date

**Eglin AFB Field Work**

>80km of 250 MHz Ground Penetrating Radar (GPR) data collected
GPR data over overwash fans collected.
>120 km of Chirp subbottom sonar data collected.
A series of preliminary cores collected.
Cores undergoing laboratory analyses.

**Storm Surge and Return Intervals**

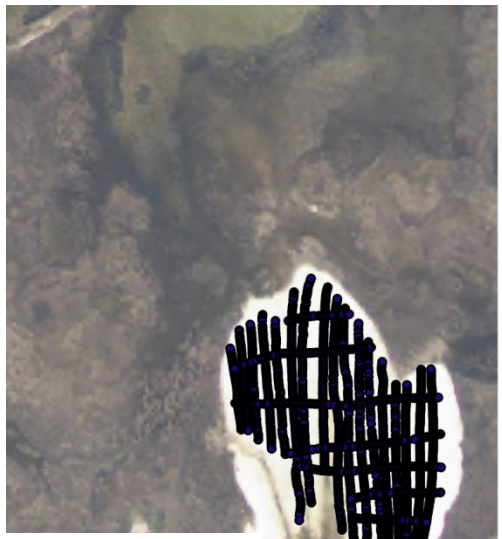
Historic and Simulated storm tracks for Eglin have been gathered.
Initial storm statistics have been generated.

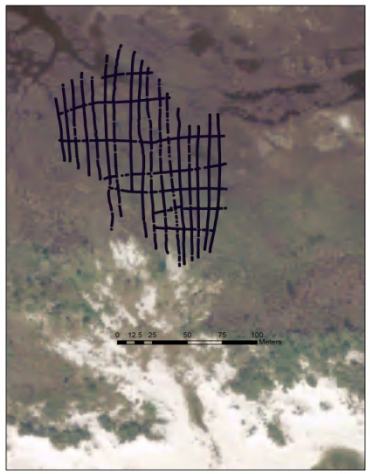
**Model Development**

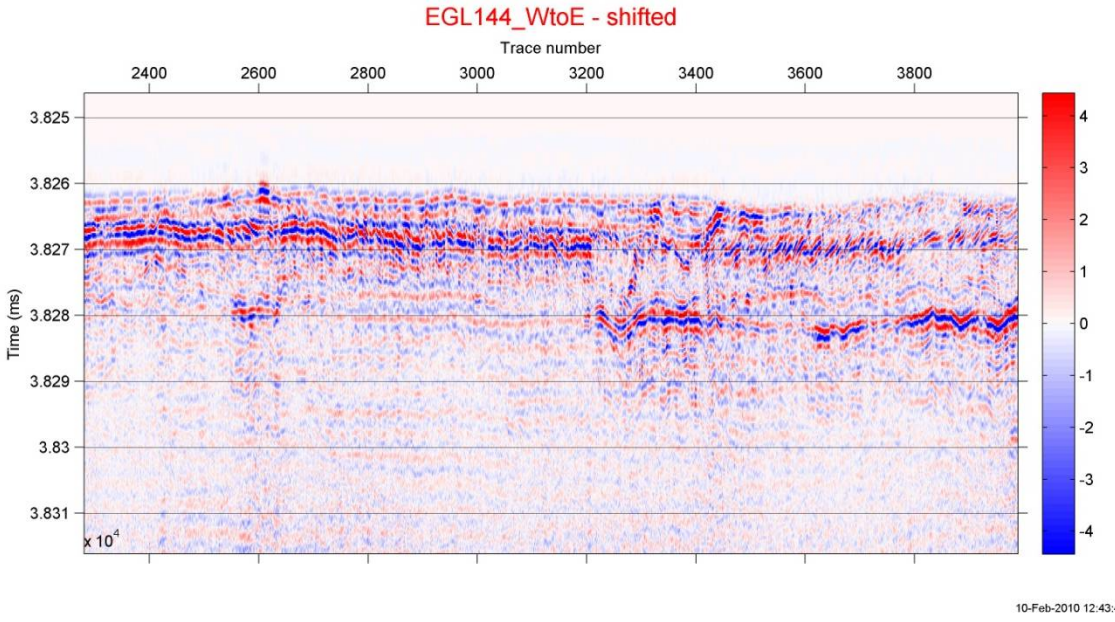
Across shore barrier migration model being tested.
Estimates of overwash needed to maintain barrier being compared to field estimates of overwash flux.

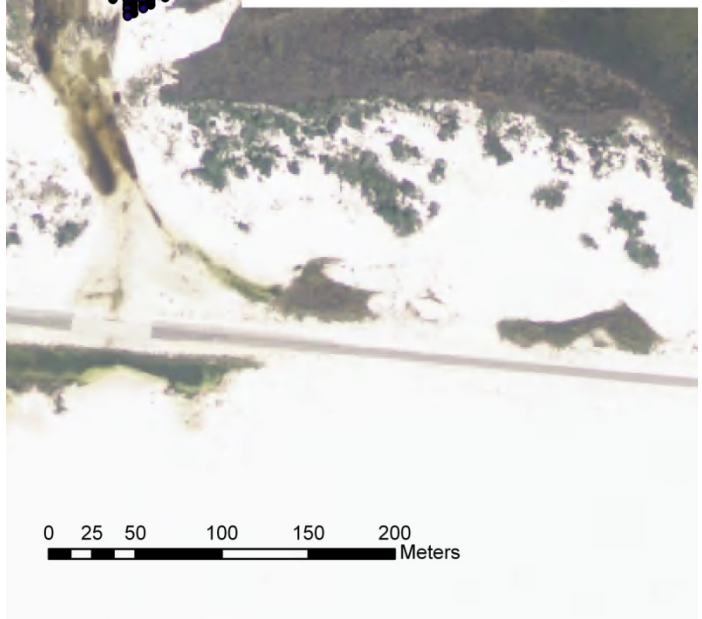
# Progress: Eglin AFB Field Work

Ground Penetrating Radar (GPR)
-3D survey over one overwash feature
-7 push cores through the deposit.
-Use these data to estimate volume of sediment transported during storm







# A Methodology for Assessing the Impact of Sea Level Rise on Representative Military Installations in the Southwestern US (SI-1703)


**Dr. Bart Chadwick, PI** - SPAWAR Systems Center Pacific

*Technical coordination, vulnerability framework, GIS & modeling, risk assessment, liaison to installations*

**Dr. Reinhard Flick** - TerraCosta Consulting Group (SIO)

*Sea level forcing, shoreline response & coastal protection systems*

**Dr. John Helly** – UCSD: San Diego Supercomputer Center

*Quantitative geospatial analysis, data management and integration*

**Dr. Walter Oechel** – SDSU: Global Change Research Group

*Regional climate change scenarios, terrestrial system response*

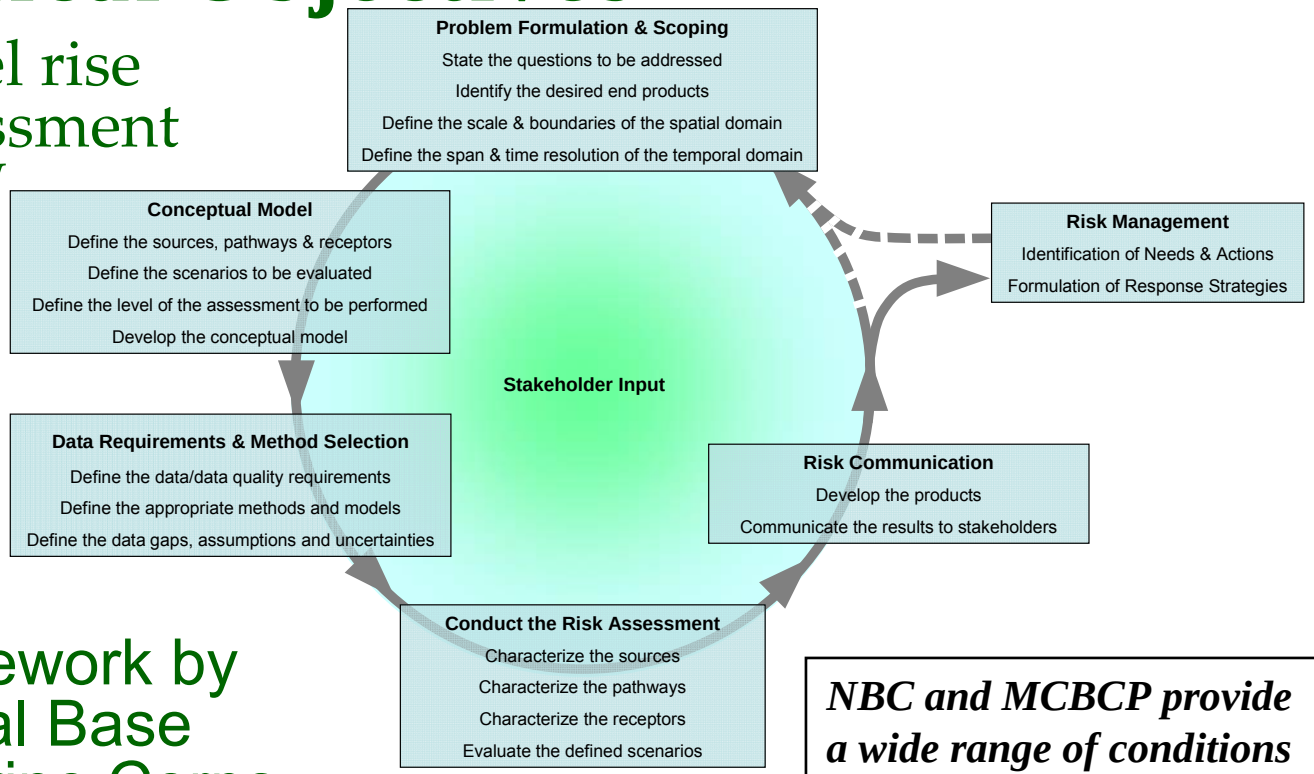
**Dr. Tracy Nishikawa** – US Geological Survey

*Groundwater system response*


SPAWAR Systems Center Pacific

# Technical Objectives

Develop a sea level rise vulnerability assessment framework for SW region DoD installations

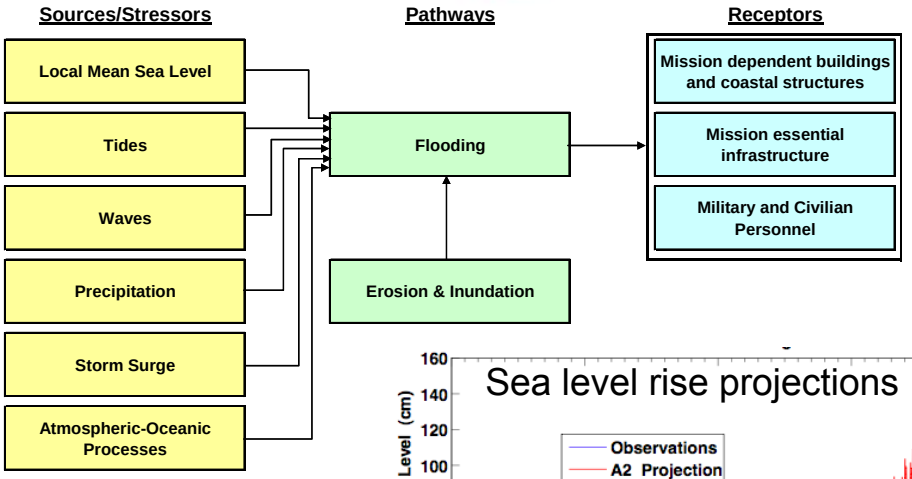



Evaluate this framework by application to Naval Base Coronado and Marine Corps Base Camp Pendleton

***NBC and MCBCP provide a wide range of conditions to challenge a vulnerability framework***


# Progress to Date

- Developed draft vulnerability framework
- Identified focus areas of concern and associated conceptual models for each installation
- Developed initial digital elevation models for each installation
- Compiled infrastructure overlays for installations
- Established local mean sea level scenarios
- Developing complete sea level projection curves including mean and variability for 2000-2100
- Initial inundation screening
- Initiated development of integrated shoreline response models
- Established initial groundwater response modeling strategy




Conceptual models